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PATENT ABSTRACTS OF JAPAN

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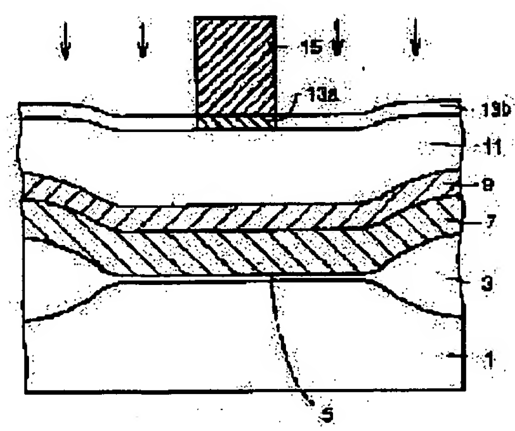
(54) FORMING METHOD OF PATTERN

(57)Abstract:
PURPOSE: To obtain a resist pattern of high dimensional precision by using a simple process.
CONSTITUTION: A silicon oxide film 11 is formed. An antireflection film composed of silicon based organic material is formed on the silicon oxide film 11. A resist pattern 15 is formed on the antireflection film so as to correspond with a specified pattern. An exposed part 13b of the antireflection film is subjected to oxygen plasma treatment by applying the resist pattern 15 to a mask. An exposed part 13a of the antireflection film and the silicon oxide film 11 are eliminated at the same time by applying the resist pattern 15 to a mask. The resist pattern 15 and a residual part 13a of the antireflection film are eliminated at the same time.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Especially this invention relates to the formation method of the pattern which carries out patterning of the layer which contains a silicon oxide in the upper layer using a photolithography about the formation method of a pattern.
[0002]
[Description of the Prior Art] In the conventional pattern formation method, after carrying out the spin coat (rotation application) of the resist on a substrate, a resist pattern is formed by irradiating light at a resist. By etching into a lower layer using this resist pattern, patterning of the lower layer is carried out according to a predetermined configuration.
[0003] However, irregularity is on a substrate, and when the irregularity is very large, in case light is irradiated at a resist, the dimensional accuracy of a resist pattern deteriorates by carrying out reflection etc. with the level difference (ground level difference) of a resist lower layer [light]. In order to lessen influence of the dimensional accuracy on the resist pattern by this ground level difference, a multilayer-resist process is used.
[0004] Drawing 11 is the outline cross section showing one process in a multilayer-resist process. In case the gate electrode of an MOS (Metal Oxide Semiconductor) transistor is formed with reference to drawing 11 , on the front face of the silicon substrate 201 in which the isolation oxide film 203 was formed first, a silicon oxide 205, the polycrystal silicon film 207, the metallic-material film 209, and a silicon oxide (SiO2) 211 carry out a laminating one by one, and are formed. The multilayer resist which consists of a lower layer resist 213 and the upper resist 217 formed by intervening in the interlayer 215 on it is formed on the front face of this silicon oxide 211.
[0005] In such a multilayer-resist process, patterning of the upper resist 217 is first carried out to a desired configuration, the pattern of this upper resist 217 is transferred to the lower layer polycrystal silicon film 207, the metallic-material film 209, etc. by etching etc., and a gate electrode is formed. Besides, the layer resist 217 is exposed and developed under the ideal conditions separated from the ground, and the high upper resist pattern of a dimensional accuracy is formed. So, it is formed with a precision sufficient [the gate electrode which consists of the polycrystal silicon film 207 and the metallic-material film 209 which are formed considering this upper resist pattern as a mask].
[0006] However, in the above-mentioned multilayer-resist process, a process becomes very complicated. Then, adoption of an antireflection film can be considered as a method of forming the high resist pattern of a dimensional accuracy in a simple process. Hereafter, the formation method of the conventional pattern which adopted the antireflection film is explained.
[0007] Drawing 12 - drawing 21 are the outline cross sections showing the formation method of the conventional pattern which adopted the antireflection film in order of a process.
[0008] With reference to drawing 12 , the isolation oxide film 303 which divides between each element into the front face of a silicon substrate 301 electrically is formed first. Then, the silicon oxide 305 thin all over a front face, the polycrystal silicon film 307, the metallic-material film 309, and silicon oxide

311 of a silicon substrate 301 carry out a laminating one by one, and are formed.
[0009] With reference to drawing 13 , the antireflection film 313 which consists of inorganic system material, such as a titanium nitride (TiN), carbon, and a silicon nitride (SiN), is formed of CVD (Chemical Vapor Deposition) or a spatter all over the front face of a silicon oxide 311.
[0010] With reference to drawing 14 , photoresist film 315a of a negative mold is formed by the spin coat method all over the front face of an antireflection film 313.
[0011] With reference to drawing 15 , a photo mask 321 is used for request partial 315b of this photoresist film 315a, and the exposure light 331 is irradiated. In order that an antireflection film 313 may absorb the exposure light 301 at the time of irradiation of this exposure light 331, the exposure light 301 is not penetrated to the lower layer silicon oxide 311. Therefore, even when the metallic-material film 309 has the high reflection factor, it becomes possible to expose photoresist film 315a, without the being influenced. Then, it is removed except field 315b by which photoresist film 315a was exposed.
[0012] Thereby with reference to drawing 16 , the resist pattern 315 by which patterning was carried out to the desired configuration is formed on the front face of an antireflection film 313.
[0013] With reference to drawing 17 , patterning of the antireflection film 313 which consists of an inorganic system material is carried out by **********ing considering this resist pattern 315 as a mask.
[0014] With reference to drawing 18 , where the resist pattern 315 is left, patterning of the silicon oxide 311 is carried out to a desired configuration.
[0015] With reference to drawing 19 , where the resist pattern 315 is left further, patterning of the metallic-material film 309, the polycrystal silicon film 307, and the silicon oxide 305 is carried out to a predetermined configuration one by one. Then, the resist pattern 315 is removed.
[0016] With reference to drawing 20 , the antireflection film 313 which consists of inorganic material is removed by etching. The gate electrode which consists of a polycrystal silicon film 307 and a metallic-material film 309 as this shows drawing 21 is formed on the gate oxide film 305.
[0017] In addition, the MOS transistor which has the source / drain field is formed by passing through processes, such as an ion implantation, from the state shown in drawing 21 .
[0018]
[Problem(s) to be Solved by the Invention] Thus, an antireflection film 313 is adopted by the conventional pattern formation method. This antireflection film 313 absorbs the exposure light 331 at the time of exposure of photoresist film 315a. For this reason, light does not penetrate to the highly transparent silicon oxide 311. Therefore, it is in the lower layer of a silicon oxide 311, and the exposure light 331 does not reach to the metallic-material film 309 which has a high reflection factor to the wavelength of the exposure light 331. Therefore, the pattern configuration of the resist pattern 315 is not influenced by the light reflected by the metallic-material film 309. Therefore, the high resist pattern 315 of a dimensional accuracy can be formed.
[0019] However, in the conventional pattern formation method, inorganic system material, such as a titanium nitride and carbon, is adopted as the antireflection film 313. In case the antireflection film 313 of this inorganic system material and its lower layer are removed by using the resist pattern 315 as a mask, once removing an antireflection film 313, it is necessary to change etching conditions and to remove the silicon oxide 311 of antireflection film 313 lower layer. That is, since etching properties differ, the antireflection film 313 and silicon oxide 311 which consist of an inorganic system material must carry out etching removal of both the layers 313 and 311 individually. Moreover, once removing the resist pattern 315 at the time of removal of the resist pattern 315, it is necessary to change etching conditions and to remove an antireflection film 313. That is, since the resist pattern 315 differs in an etching property from an antireflection film 313, both the layers 315 and 313 must ********** individually. Thus, by the conventional pattern formation method, there was a trouble that the removal process of each film after forming a resist pattern became complicated.
[0020] Moreover, the antireflection film 313 which consists of inorganic system material, such as a titanium nitride and carbon, is formed of CVD or a spatter. For this reason, the expensive vacuum devices for CVD or a spatter are needed for formation of an antireflection film 313.
[0021] this invention was made in order to solve the above troubles, and it aims at obtaining the high

resist pattern of a dimensional accuracy in a simple process.
[0022]
[Means for Solving the Problem] this invention is the formation method of the pattern which carries out patterning of the layer containing a silicon oxide to the upper layer using a photolithography, and is equipped with the following processes.
[0023] A silicon oxide is formed first. And the antireflection film which consists of a silicon system organic material is formed on a silicon oxide. And according to a predetermined pattern, a photoresist film is formed on an antireflection film. And oxygen plasma treatment is performed to an antireflection film by using a photoresist film as a mask. And the antireflection film and silicon oxide which are exposed from a photoresist film by using a photoresist film as a mask are removed. And the photoresist film used as a mask and the antireflection film which remained are removed.
[0024]
[Function] By the formation method of the pattern of this invention, a photoresist film is formed according to a predetermined pattern on an antireflection film. For this reason, an antireflection film absorbs exposure light at the time of exposure of a photoresist film. Therefore, exposure light is suppressed in the upper layer of an antireflection film being penetrated to reflection or a lower layer. Therefore, the dimensional accuracy of a photoresist film becomes high.
[0025] Moreover, the antireflection film consists of a silicon system organic material. If oxygen plasma treatment is performed to this antireflection film, the etching property of an antireflection film will become the same as a silicon oxide substantially. For this reason, it is removable on the etching conditions that an antireflection film and its lower layer silicon oxide are the same. Therefore, an antireflection film and a silicon oxide become removable simultaneously. Moreover, generally the photoresist film consists of an organic material. For this reason, it is removable on the conditions that a photoresist film and its lower layer antireflection film are the same. Therefore, a photoresist film and an antireflection film become removable simultaneously. Thus, each class individually removed by the conventional pattern formation method is simultaneously removable respectively in this invention. Therefore, simplification of the formation process of a pattern can be attained.
[0026] Furthermore, the silicon system organic material used for an antireflection film is a material generally used for a photoresist film. For this reason, in formation of this antireflection film, it is simple, and the rotation applying method which is the stable thin film forming method can be used. Therefore, as compared with the expensive vacuum devices for the conventional CVD or a spatter, facilitation of equipment can also be attained by this invention.
[0027]
[Example] Hereafter, the formation method of the pattern of this invention is explained using drawing.
[0028] Drawing 1 - drawing 9 are the outline cross sections showing the formation method of the pattern in one example of this invention in order of a process. With reference to drawing 1 , the formation process of the gate electrode of an MOS transistor is explained first. On the front face of the silicon substrate 1 in which the separation oxide film 3 was formed first, a silicon oxide 5, the polycrystal silicon film 7, the metallic-material film 9, and a silicon oxide 11 carry out a laminating one by one, and are formed.
[0029] With reference to drawing 2 , the antireflection film 13 which consists of a silicon system organic material by the spin coat method is formed on the front face of a silicon oxide 11. In this antireflection film 13, it is [0030].
[Formula 1]

$$\left(\begin{array}{ccc} R_1 & & R_5 \\ | & & | \\ Si & - & R_4 \\ | & & | \\ R_2 & & R_3 \end{array} \right)_n$$

The thing of ****** is used. In addition, R1, R2, R3, R4, and R5 It may consist of carbon (C), oxygen (O), nitrogen (N), hydrogen (H), etc., and silicon (Si) may be included.
[0031] With reference to drawing 3 , photoresist film 15a is applied by the spin coat method all over the front face of an antireflection film 13.
[0032] With reference to drawing 4 , the exposure light 31 is irradiated by the photo mask 21 by field 15b by which photoresist film 15a should be exposed. As for this exposure light 31, for example, KrF excimer light (lambda= 248nm) is used as exposure wavelength. What shows a high absorption property to KrF wavelength among the things of the above-mentioned composition is used for the antireflection film 13 which consists of a silicon system organic material in the case of this exposure. For this reason, the exposure light 31 irradiated by field 15b which should be exposed is absorbed by the antireflection film 13. That is, the exposure light 31 which reached the antireflection film 13 is not penetrated [in the upper layer of an antireflection film 13] to reflection or a lower layer. Therefore, the reflection of the exposure light 31 and the influence of interference in the lower layer of photoresist film 15a are lost, and exposure energy becomes stable. Then, photoresist film 15a is melted by alkali development.
[0033] Since the negative resist is used for photoresist film 15a with reference to drawing 5 , it is melted except the exposure section by alkali development, and the resist pattern 15 is formed. Since this resist pattern 15 is exposed with the exposure energy which was not influenced [reflection of exposure light, and] of interference, but was stabilized at the time of exposure, it has close dimensional accuracy. The front face of an antireflection film 13 is exposed with formation of the resist pattern 15.
[0034] With reference to drawing 6 , oxygen (O2) plasma treatment is performed to the front face of the antireflection film 13 to expose. Thereby, only the outcrop 13b of an antireflection film 13 oxidizes alternatively. Outcrop 13b of an antireflection film 13 deteriorates on the film of an inorganic system by this oxygen plasma treatment, and the etching property becomes equivalent substantially with the lower layer silicon oxide 11. Then, etching removal of antireflection film 13b and the silicon oxide 11 which expose the resist pattern 15 as a mask is carried out. Under the present circumstances, since outcrop 13b of an antireflection film and a silicon oxide 11 have the substantially equivalent etching property, **********ing on the same etching conditions is possible. Therefore, outcrop 13b of an antireflection film and a silicon oxide 11 are simultaneously removable.
[0035] With reference to drawing 7 , patterning of the silicon oxide 11 is carried out to a predetermined configuration by this etching.
[0036] With reference to drawing 8 , where the resist pattern 15 is left, etching removal of the metallic-material film 9, the polycrystal silicon film 7, and the silicon oxide 5 is carried out one by one. The gate electrodes 7 and 9 by which patterning was carried out by this to the predetermined configuration which consists of a polycrystal silicon film 7 and a metallic-material film 9 will be formed on the front face of the gate oxide film 5. Then, the resist pattern 15 and antireflection film 13a are removed. Generally the resist pattern 15 is formed from an organic material. For this reason, it is possible to remove antireflection film 13a which consists of a resist pattern 15 and a silicon system organic material on the same conditions. Therefore, the resist pattern 15 and antireflection film 13a are simultaneously removable. It will be in the state which shows in drawing 9 by removal of this resist pattern 15 and antireflection film 13a.
[0037] The silicon system organic material is used for the antireflection film 13 in the pattern formation method of this invention. For this reason, in the pattern formation method of this invention, simplification of the process after patterning of a photoresist can be attained as compared with the conventional example. Hereafter, that is explained in detail.
[0038] Drawing 10 (a) and (b) are the block diagrams showing typically the process after patterning of the photoresist in the conventional example and the example of this invention. With reference to drawing 10 (a), an inorganic system material is first used for the antireflection film in the conventional example. A titanium nitride, carbon, etc. are used for this inorganic system material in consideration of being the material which has a high absorption property to the wavelength of exposure light. For this reason, an antireflection film and a silicon-oxide (SiO2) film cannot be etched simultaneously. Therefore, etching (step112) of an inorganic system antireflection film and etching (step113) of a

silicon-oxide (SiO_2) film are performed separately. Moreover, since the antireflection film consists of an inorganic system material, it is simultaneously [with a photoresist] unremovable at the time of removal of a photoresist. Therefore, removal (step114) of a photoresist and etching (step115) of an inorganic system antireflection film are performed separately.

[0039] Next, with reference to drawing 10 (b), the silicon system organic material is used for the antireflection film in the example of this invention. (step102) and the etching property of an antireflection film become equivalent substantially with a silicon oxide by performing oxygen (O_2) plasma treatment to this silicon system organic material. For this reason, it can etch simultaneously with the lower layer silicon oxide (SiO_2) of an antireflection film (step103). Moreover, generally a photoresist consists of an organic system material. For this reason, the antireflection film which consists of a photoresist and a silicon system organic material which remained is simultaneously removable (step104).

[0040] From the above, simplification of a process can be attained by the pattern formation method of this invention in the process after patterning (step 101 and 111) of a photoresist as compared with the conventional example.

[0041] Moreover, the silicon system organic material used for an antireflection film is a material generally used for a photoresist film. For this reason, in formation of this antireflection film, it is simple and the rotation applying method which is the stable thin film forming method can be used. Therefore, facilitation of equipment can also be attained as compared with the expensive vacuum devices for the conventional CVD or a spatter.

[0042]

[Effect of the Invention] By the formation method of the pattern of this invention, a photoresist film is formed according to a predetermined pattern on an antireflection film. Since reflection and transparency of the exposure light at the time of exposure are suppressed by this antireflection film, the high photoresist film of a dimensional accuracy can be obtained.

[0043] Moreover, the antireflection film consists of a silicon system organic material. For this reason, an antireflection film and its lower layer silicon oxide can carry out etching removal simultaneously. Moreover, it is also possible to carry out etching removal of a photoresist film and the antireflection film simultaneously. Therefore, simplification of the formation process of a pattern can be attained.

[0044] Furthermore, the antireflection film which consists of a silicon system organic material can be formed by the rotation applying method which is the simple and stabilized thin film forming method. Therefore, facilitation of equipment can be attained.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] The process which is the formation method of the pattern which carries out patterning of the layer containing a silicon oxide to the upper layer using a photolithography, and forms a silicon oxide, The process which forms the antireflection film which consists of a silicon system organic material on the aforementioned silicon oxide, The process which forms a photoresist film according to a predetermined pattern on the aforementioned antireflection film, The process which performs oxygen plasma treatment to the aforementioned antireflection film by using the aforementioned photoresist film as a mask, The formation method of a pattern equipped with the process which removes the process which removes the aforementioned antireflection film exposed from the aforementioned photoresist film by using the aforementioned photoresist film as a mask, and the aforementioned silicon oxide, and the aforementioned photoresist film used as the aforementioned mask and the aforementioned antireflection film which remained.

[Translation done.]